Announcements

- Homework for tomorrow…

  Ch. 29: CQ 3, Probs. 4, 6, & 8

  CQ10: a) ΔV_C -> ΔV_C b) C -> $C/2$ c) Q -> $Q/2$
  29.20: (240/79) μF
  29.22: 20 μF in parallel
  29.54: $Q_1 = 4\ \mu$C, $Q_2 = 12\ \mu$C, $Q_3 = 16\ \mu$C, $\Delta V_1 = \Delta V_2 = 1$V, $\Delta V_3 = 8$V

- Office hours…

  MW 10-11 am
  TR 9-10 am
  F 12-1 pm

- Tutorial Learning Center (TLC) hours:

  MTWR 8-6 pm
  F 8-11 am, 2-5 pm
  Su 1-5 pm

Chapter 30

Current & Resistance

(*Creating a Current*)

Review…

- *Energy stored in a capacitor…*

$$\boxed{U_C = \frac{Q^2}{2C} = \frac{1}{2}C(\Delta V_C)^2}$$

- *Energy density of a capacitor…*

$$\boxed{u_E = \frac{1}{2}\epsilon_0 E^2}$$

- *Electron current…*

Drift velocity

$$\boxed{i_e = n_e A v_d}$$

e^- number density

cross-sectional area

Quiz Question 1

A wire carries a current. If both the wire diameter and the electron drift speed are *doubled*, the electron current increases by a factor of

1. 2.
2. 4.
3. 6.
4. 8.
5. Some other value.

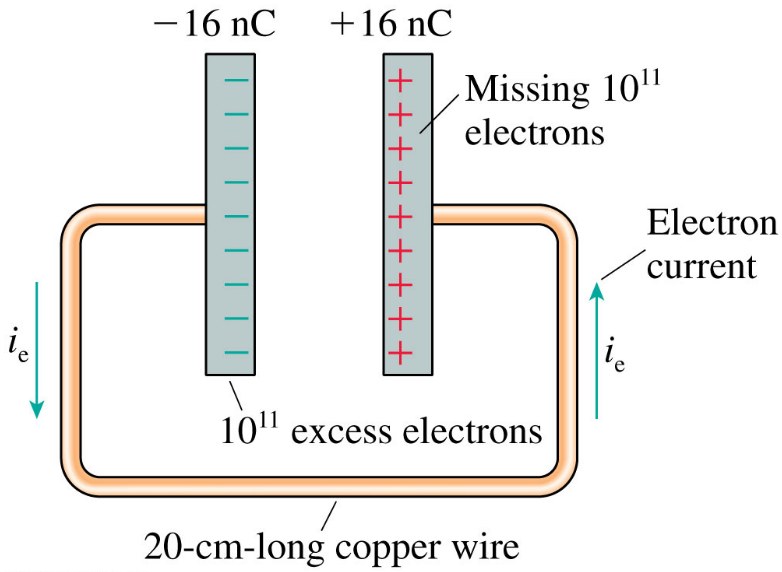
i.e. 30.1:
The size of the electron current

What is the electron current in a 2.0 mm diameter copper wire if the electron drift speed is 1.0×10^{-4} m/s?

Given: $n_e = 8.5 \times 10^{28}$ m^{-3} for copper.

Discharging a capacitor…

How long does it take to discharge the capacitor?



30.2:
Creating a Current

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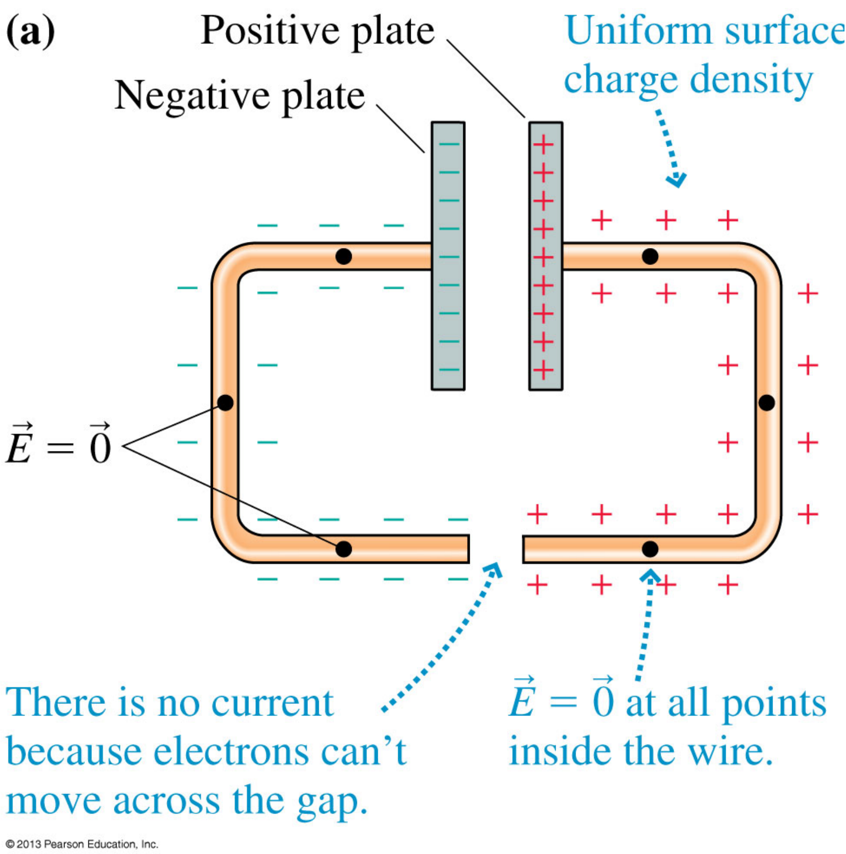
- Q: What creates a current?
- Q: But a conductor in electrostatic equilibrium has an *E*-field of ZERO inside a conductor?
- Q: If there is a *non-zero E*-field, then there is a *non-zero F*, so shouldn't my electrons accelerate?
  - instead of move at a *constant drift velocity*, v_d?

Establishing an *E*-field in a Wire

Notice:

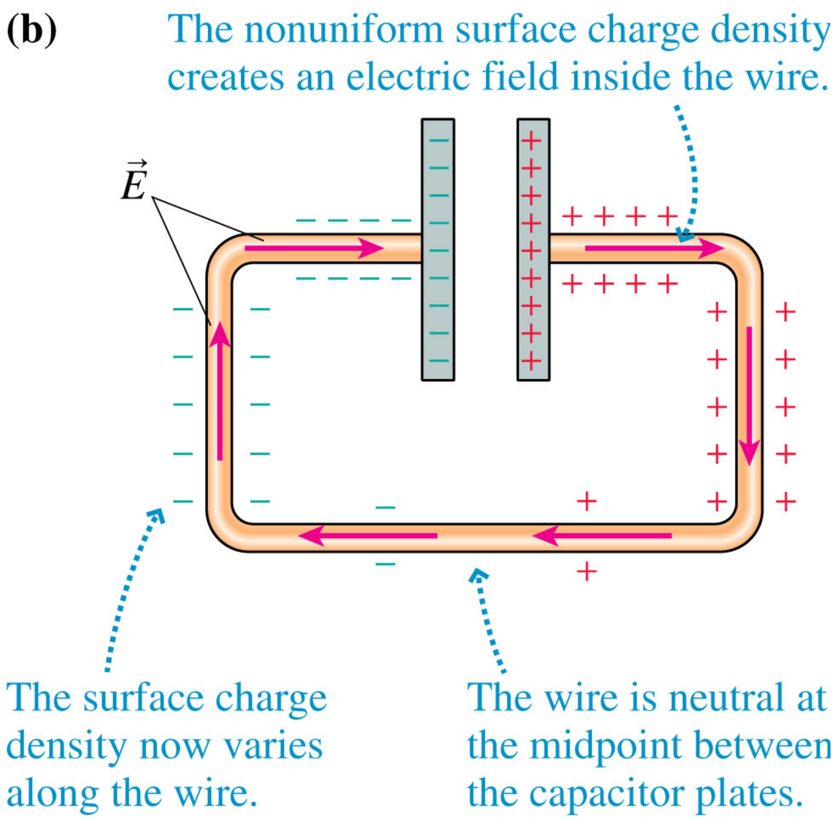
- conductors are in *electrostatic equilibrium*.
- $E = 0$ inside the wire, *all* excess charge resides on the surface.
- *Surface charge density* is uniform.



Establishing an *E*-field in a Wire

Notice:

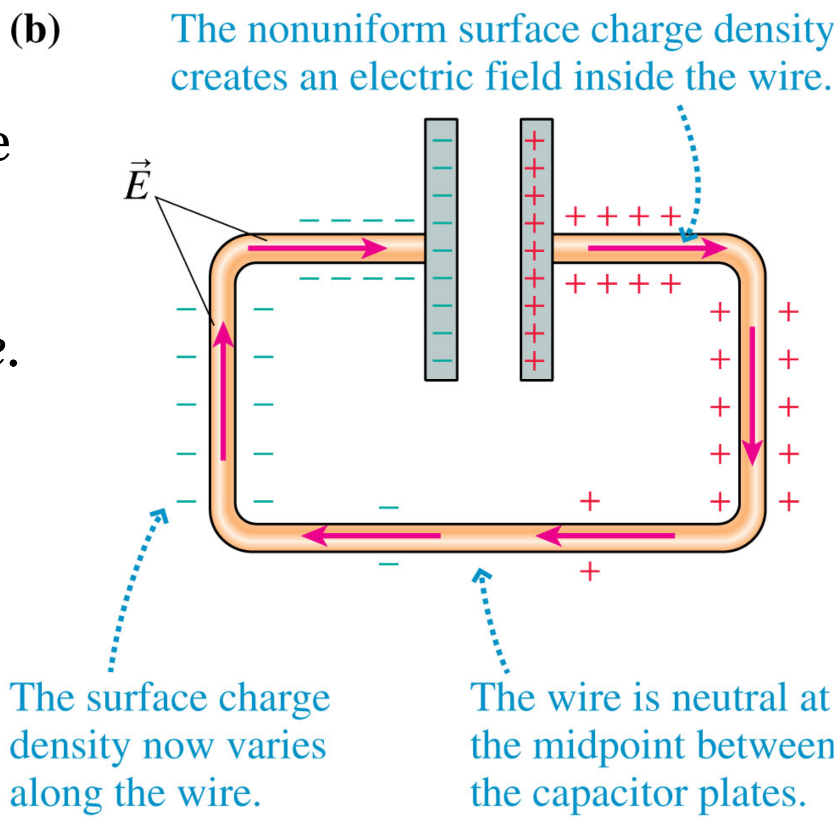
- Within Δt ~ 1 ns, sea of electrons shift slightly.
- conductors are NOT in *electrostatic equilibrium*.
- *Surface charge density* is no longer uniform.
- *Non-zero E*-field inside the wire.
- *E*-field creates a current.



Establishing an E-field in a Wire

Notice:

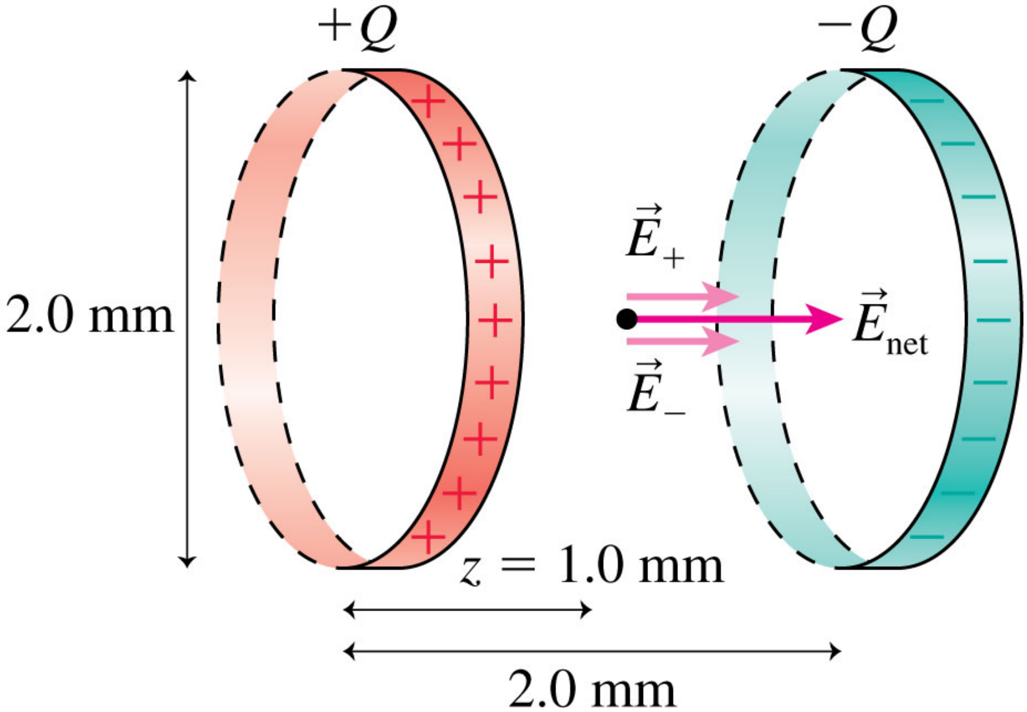
- *Surface charges* are NOT the moving charges.
- i_e (electron current) is *inside* the wire, NOT on the *surface*.



i.e. 30.2: The surface charge on a current-carrying wire

Consider a typical E-field strength of 0.01 V/m. Two 2.0 mm diameter rings are 2.0 mm apart. They are charged to $\pm Q$.

What is Q?



A Model of Conduction

Q: If there is a *non-zero E*-field, then there is a *non-zero F*, so shouldn't my electrons accelerate?

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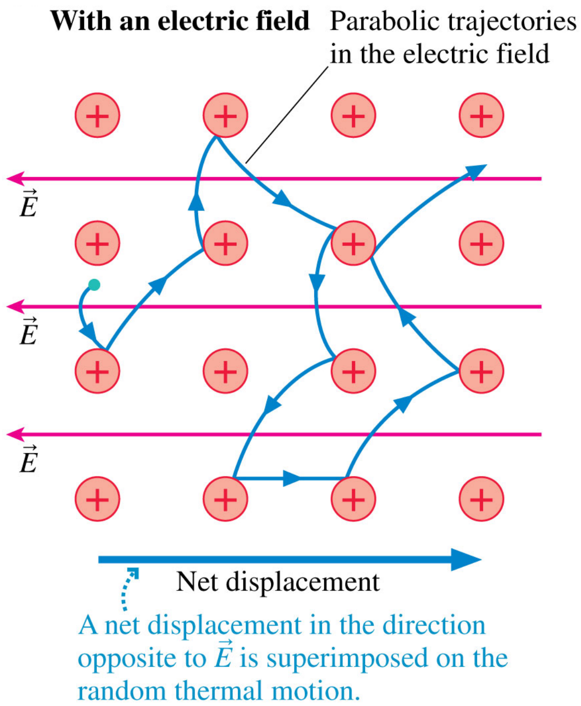

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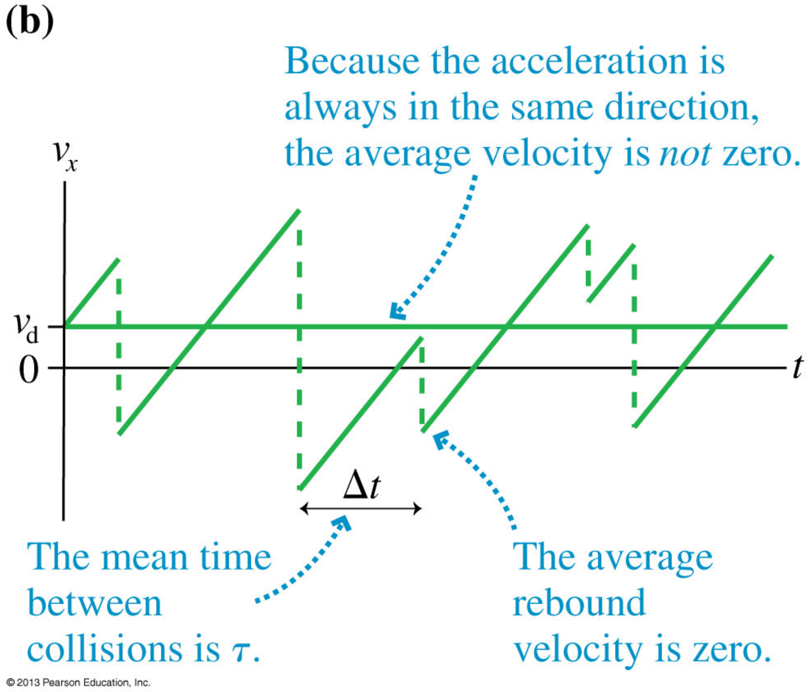

A Model of Conduction

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$$\boxed{v_d = \frac{e\tau}{m}E}$$

so the electron current is..

$$\boxed{i_e = \frac{n_e e\tau A}{m}E}$$